

Original Research Article

<https://doi.org/10.20546/ijcmas.2020.909.094>

Response of Clusterbean (*Cyamopsis tetragonoloba* L.) to Weed Management Practices and Phosphorus Levels under Sub-tropical Climatic Conditions of Rajasthan

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ABSTRACT

Two field experiments were conducted to evaluate the effect of weed management practices and phosphorus level on growth, yield and economics of cluster bean in consecutive *kharif* season of 2015 and 2016 at Instructional Farm (Agronomy), Rajasthan College of Agriculture, Udaipur. Field trial was conducted at same site during both the years in split plot design and replicated thrice with eight weed management practice *viz.* Pendimethalin 1.0 kg ha⁻¹ as pre-emergence (PE), Pendimethalin 1.0 kg ha⁻¹ as PE + hand weeding (HW) 30 DAS, Pendimethalin + Imazethapyr 0.8 kg ha⁻¹ PE, Pendimethalin + Imazethapyr 0.8 kg ha⁻¹ PE + HW 30 DAS, Imazethapyr + Imazamox 0.05 kg ha⁻¹ at 15 DAS, Imazethapyr + Imazamox 0.05 kg ha⁻¹ at 15 DAS + HW 30 DAS, two HW at 15 and 30 DAS and weedy check in main-plot and four levels of phosphorus *i.e.* 0, 20, 40 and 60 kg ha⁻¹ in sub plots. The allocation of treatments among replications, sub blocks and ultimate plots was carried out purely by following the principles of randomization. Results showed that among the various weed control treatments, two hand weedings (HW) at 15 and 30 DAS gave significantly higher growth parameters *viz.*, plant height (58.68 & 58.78 cm at 50 DAS and 89.48 & 90.38 cm) and dry matter accumulation plant⁻¹ (10.54 & 10.61 g plant⁻¹ at 50 DAS and 15.02 and 15.23 g plant⁻¹ at 75 DAS) which was significantly superior to rest of the treatments, respectively. Similarly, the highest seed yield (1119 and 1134 kg ha⁻¹), haulm yield (2401 and 2399 kg ha⁻¹) and biological yield (3520 and 3533 kg ha⁻¹) were also recorded with tow HW which was closely followed by Pendimethalin 1.0 kg + Imazethapyr @ 0.8 kg ha⁻¹ PE + HW 30 DAS and Imazethapyr + Imazethapyr 0.05 kg ha⁻¹ + HW 30 DAS. However, the maximum net return (₹ 43228 and 5153 ha⁻¹) and B:C ratio (2.25 and 2.57) was found in Pendimethalin 1.0 kg + Imazethapyr @ 0.8 kg ha⁻¹ PE + HW 30 DAS which was closely followed by Imazethapyr + Imazethapyr 0.05 kg ha⁻¹ + HW 30 DAS during both the respective years. Application of 60 kg P₂O₅ ha⁻¹ recorded significantly higher growth parameters, yields and net returns, however, the maximum B: C ratio was noted in 40 kg P₂O₅ ha⁻¹ over rest of the treatments during both years.

Keywords

Weed management,
Phosphorus levels,
Growth parameters,
yield, Economics

Article Info

Accepted:
07 August 2020
Available Online:
10 September 2020

Introduction

Among the *kharif* legumes clusterbean (*Cyamopsis tetragonoloba* L. Taub) is important crop and popularly known as “Guar” in India. It is mostly suitable for arid and semi-arid conditions and cultivated for green vegetables, dry pods, green manure as well as fodder purpose. It is also drought tolerant because of it has deep tap root system which enables to utilize the available moisture more efficiently and offers to sustain under rainfed condition. This crop has ability to flowering and fruiting under short terms water deficit conditions. Due to high capacity to recover from water stress it is one of the best legume crops for the climatic situation of Rajasthan (Kherawat *et al.*, 2013). In India, the major producing state of clusterbean are Rajasthan, Haryana, Punjab, Gujarat and to a limited extent in Uttar Pradesh and Madhya Pradesh. Among these states Rajasthan is the major producing state in the country with ranked first with respect to both area (47.87 lakh ha) and production (27.48 lakh tones) and an average productivity of 465 kg ha⁻¹ (Anonymous, 2016).

Amongst agronomic factors known to augment crop production, appropriate weed and nutrient management are considered to be the most important. Being a rainy season crop, clusterbean suffers badly due to severe competition by mixed weed flora. These weeds utilize natural resources more efficiently than crop plants to achieve a fast and vigorous growth which results they provide a tough competition to the crop plants. Initial 30 days of sowing is very critical and presence of weeds beyond this results in yield reduction up to 93.22 per cent (Sharma *et al.*, 2016 and Brar, 2018). Therefore, weed control needs to be restored to exploit the yield potential of this crop. Phosphorus is the second most important plant nutrient which plays a vital role in plant

growth and development. Its application led to increase in plant height (Kumawat *et al.*, 2009 a, b), extensive root growth (Liang *et al.*, 1996), total dry weight (Kumawat *et al.*, 2009c) and leaf area of clusterbean. Phosphorus also influences the symbiotic nitrogen fixation, yield and quality of clusterbean pods. Phosphorus has positive effect on nodulation (Tilak *et al.*, 2006 and Kumawat *et al.*, 2018) and activity of rhizobia present in root nodules of leguminous plant (Cassman *et al.*, 1980, Vessey, 1994 and Kumawat *et al.*, 2010). Keeping these factors in view, the present investigation was planned with an objective the study the effect of weed management practices and phosphorus on growth, yield and economics of clusterbean.

Materials and Methods

The present investigation was conducted during *kharif* 2015 and 2016 at Instructional Farm (Agronomy), Rajasthan College of Agriculture, Udaipur with 8 weed management practices [Pendimethalin 1.0 kg ha⁻¹ as Pre-emergence (PE), Pendimethalin 1.0 kg ha⁻¹ as PE + hand weed (HW) 30 DAS, Pendimethalin + Imazethapyr (Ready mix=RM) 0.8 kg ha⁻¹ PE, Pendimethalin + Imazethapyr (RM) 0.8 kg ha⁻¹ PE + HW 30 DAS, Imazethapyr + Imazamox (RM) 0.05 kg ha⁻¹ 15 DAS, Imazethapyr + Imazamox (RM) 0.05 kg ha⁻¹ 15 DAS + HW 30 DAS, two HW at 15 and 30 DAS and weedy check] were allotted in main plots and four phosphorus levels (0, 20, 40 and 60 kg ha⁻¹) in sub plots to evaluate their effects on growth, yield and economics of cluster bean. The experiment was laid out in split plot design with replicated thrice. The experimental site was situated at 24° 35' N latitude, 74°42' E longitude and altitude of 579.5 m above mean sea level. This region falls under agro-climatic zone IV-A of Rajasthan which possesses typical sub-tropical climatic conditions and characterized by mild winters

and moderate summers. The soil of experimental site was clay loam in texture and alkaline in reaction (pH 8.0 and 8.1). The soil was medium in available nitrogen (284.56 and 279.61 kg ha⁻¹) and phosphorus (20.42 and 19.27 kg ha⁻¹) and high in available potassium (322.83 and 319.17 kg ha⁻¹) in 2015 and 2016, respectively. Test crop clusterbean was grown @ 20 kg ha⁻¹ at 30 cm row to row and 10 cm plant to plant spacing.

The growth parameters like plant height and dry matter accumulation plant⁻¹ were recorded at 50 DAS and 75 DAS from five plants randomly collected from individual treated plot. After threshing and winnowing seed yield from net plot area was weighed and expressed as kg ha⁻¹. The haulm yield (kg ha⁻¹) was calculated by subtracting the corresponding seed yield from the biological yield. Pod and haulm was dried completely, weighed and computed for biological yield as kg ha⁻¹. The harvest index was calculated by formula suggested by Donald and Hamblin, 1976 as given below:

$$HI (\%) = \frac{\text{Economic yield (kg ha}^{-1}\text{)}}{\text{Biological yield (kg ha}^{-1}\text{)}} \times 100$$

The economics of different treatment combinations were worked out in terms of net returns ha⁻¹ and B:C ratio. The expenses incurred during experimentation were computed as cost of cultivation. Gross return was calculated by multiplying the total economic yield ha⁻¹ with their current market price. Net return and B:C ratio was calculated with the help of the following formula:

$$\text{Net return (₹ ha}^{-1}\text{)} = \text{Gross return (₹ ha}^{-1}\text{)} - \text{Cost of cultivation (₹ ha}^{-1}\text{)}$$

$$\text{Benefit :cost ratio} = \frac{\text{Net return (₹ ha}^{-1}\text{)}}{\text{Cost of cultivation (₹ ha}^{-1}\text{)}}$$

Results and Discussion

Effect on growth

The critical examination of data (Table 1) revealed that weed management treatments brought about a significant improvement in height and dry matter plant⁻¹ at 50 and 75 DAS during both years of investigations. Twice hand weeding gave maximum height and dry matter compared with control. Among the various weed management treatments, combined application of Pendimethalin 1.0 kg + Imazethapyr 0.8 kg ha⁻¹ + HW 30 DAS and Imazethapyr + Imazethapyr 0.05 kg ha⁻¹ + HW 30 DAS produced higher plant height and dry matter production plant⁻¹ during both the years. This was attributed to their higher weed control efficiency which proved cleaner and more conducive environment for growth of the crop, thereby improvement in nutrient uptake by the crop compared to weedy check. Results are obtained in close conformity with the finding of Singh *et al.*, (2014), Saras *et al.*, (2016), Sharma *et al.*, (2017) and Singh *et al.*, (2020).

Further data revealed that applications of 60 kg P ha⁻¹ gave higher values of plant height and dry matter production plant⁻¹ which was significantly superior over the rest of phosphorus levels except 40 kg P₂O₅ ha⁻¹ during both the year. The phosphorus is a structural component of the membrane system of the cell, the chloroplast and mitochondria. It is a constituent of ADP, ATP, nucleic acid, phospholipids, and the co-enzyme, NAD, NADP. It stimulates early root development and growth, which helps in plant establishment. It also enhances the development of reproductive parts, thus, bringing about maturity. Obviously the plant supplied adequately phosphorus levels produced more leaves and recorded higher accumulation of photosynthates yielding higher dry matter production. Increasing in

plant height and dry matter accumulation with increase levels of phosphorus are in close conformity with the finding of several researchers are Ayub *et al.*, (2013), Bhathal and Kumar, (2016) Verma *et al.*, (2017a), Singh *et al.*, (2017) and Kumawat *et al.*, (2019).

Effect on yields

Data indicated that weed management treatments and phosphorus levels significantly increased seed, halum, biological yield and

harvest index of clusterbean over weedy check during both the years (Table 2). Two hand weeding again proved superiority in respect to seed, haulm, biological yield and harvest index in comparison to rest of the treatments. Among the herbicidal treatments, the maximum seed, haulm and biological yield was obtained with Pendimethalin + Imazethapyr (RM) @ 0.8 kg ha⁻¹ along with one hand weeding (HW) at 30 DAS which was found significantly superior over the rest of treatment except Imazethapyr + Imazamox (RM) @ 0.5 kg ha⁻¹ + hand weeding.

Table.1 Effect of weed management practices and phosphorus levels on plant plant height, plant dry matter (g) and harvest index of cluster bean

Treatments	Plant height (cm)				Plant dry matter plant ⁻¹ (g)				Harvest Index (%)	
	50 DAS		75 DAS		50 DAS		75 DAS			
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Weed management practices										
Pendimethalin 1.0 kg ha⁻¹	51.45	51.64	80.16	80.50	8.54	8.58	11.04	11.01	29.43	30.79
Pendimethalin kg ha⁻¹ + HW 30 DAS	55.77	55.89	83.11	83.37	10.03	9.97	14.01	13.94	31.00	30.87
Pendimethalin 1.0 kg + Imazethapyr 0.8 kg ha⁻¹	53.30	53.50	82.53	82.90	9.56	9.58	12.33	12.28	31.90	33.15
Pendimethalin 1.0 kg + Imazethapyr 0.8 kg ha⁻¹ + HW 30 DAS	57.55	57.78	86.95	87.19	10.21	10.30	14.56	14.61	32.59	32.71
Imazethapyr + Imazethapyr 0.05 kg ha⁻¹	52.36	52.42	80.97	81.86	9.18	9.23	12.01	11.96	33.20	32.45
Imazethapyr + Imazethapyr 0.05 kg ha⁻¹ + HW 30 DAS	56.36	56.43	86.46	86.95	10.19	10.04	14.37	14.60	32.39	33.15
Two HW 15 and 30 DAS	58.68	58.78	89.48	90.38	10.54	10.61	15.02	15.23	31.11	32.07
Weedy check	48.59	48.77	76.33	76.82	5.54	5.49	7.72	7.65	24.27	22.38
SEm±	1.49	1.34	2.30	2.34	0.24	0.24	0.31	0.38	1.06	0.85
CD (P=0.05)	4.52	4.06	6.99	7.09	0.72	0.72	0.95	1.15	3.21	2.59
Phosphorus (kg ha⁻¹)										
0	50.49	50.53	75.64	75.36	8.53	8.55	10.78	10.81	27.88	30.18
20	53.86	54.10	82.52	83.00	8.97	9.02	12.20	12.22	31.51	30.93
40	56.20	56.31	85.86	86.53	9.54	9.52	13.54	13.58	31.76	31.30
60	56.47	56.66	88.97	90.08	9.87	9.81	14.01	14.02	31.80	31.36
SEm±	0.81	0.72	1.08	1.25	0.13	0.14	0.17	0.17	0.34	0.23
CD (P=0.05)	2.31	2.04	3.07	3.55	0.38	0.39	0.50	0.47	0.95	0.66

Table.2 Effect of weed management practices and phosphorus levels on yield and economics of cluster bean

Treatments	Seed yield (kg ha ⁻¹)		Haulm yield (kg ha ⁻¹)		Biological yield (kg ha ⁻¹)		Net returns (₹ ha ⁻¹)		B:C ratio	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Weed management practices										
Pendimethalin 1.0 kg ha ⁻¹	637	674	1521	1516	2158	2190	20911	25931	1.22	1.50
Pendimethalin kg ha ⁻¹ + HW 30 DAS	963	986	2155	2203	3118	3189	36914	42974	1.85	2.14
Pendimethalin 1.0 kg + Imazethapyr 0.8 kg ha ⁻¹	820	854	1744	1718	2564	2572	31023	36633	1.82	2.13
Pendimethalin 1.0 + Imazethapyr 0.8 kg ha ⁻¹ + HW 30 DAS	1107	1131	2294	2331	3401	3463	44711	51539	2.25	2.57
Imazethapyr + Imazethapyr 0.05 kg ha ⁻¹	809	800	1625	1667	2434	2468	30583	34093	1.85	2.04
Imazethapyr + Imazethapyr 0.05 kg ha ⁻¹ + HW 30 DAS	1062	1099	2225	2221	3287	3320	43228	49895	2.22	2.56
Two HW 15 and 30 DAS	1119	1134	2401	2399	3520	3533	42774	49417	1.91	2.18
Weedy check	374	386	1105	1324	1478	1710	8342	11568	0.54	0.76
SEm±	34	26	84	76	97	82	1816	1506	0.09	0.08
CD (P=0.05)	104	80	255	229	296	249	5509	4568	0.28	0.23
Phosphorus (kg ha⁻¹)										
0	643	725	1581	1627	2224	2352	21635	29308	1.24	1.67
20	863	861	1845	1878	2708	2738	32709	36840	1.79	2.00
40	960	964	2036	2069	2995	3033	37347	42345	1.94	2.18
60	980	982	2074	2117	3053	3099	37551	42533	1.86	2.09
SEm±	12	9	32	26	38	32	655	575	0.03	0.03
CD (P=0.05)	34	27	90	73	109	90	1864	1636	0.09	0.08

Similarly, the higher harvest index was noted with Pendimethalin + Imazethapyr (RM) @ 0.8 kg ha⁻¹ + 1 HW at 30 DAS which was found significantly superior over weedy check and Pendimethalin 1.0 kg ha⁻¹, however, in 2016 this value was achieved significantly highest with Pendimethalin + Imazethapyr (RM) @ 0.8 kg ha⁻¹ over the weedy check, Pendimethalin 1.0 kg ha⁻¹ and Pendimethalin 1.0 kg ha⁻¹ + HW 30 DAS. This might be due to better weed management which rendered favourable condition like increased availability of nutrient, moisture, light and

other factors to the crop plant, which resulted in better growth and higher dry matter production of plants. Due to minimum crop weed competition two hand weeding (at 15 and 30 DAS) recorded maximum seed yield, haulm yield and total biological yield which was expected. These results are in line with Deshmukh *et al.*, (2014), Sharma *et al.*, (2017) and Poornima *et al.*, (2018).

The application of 60 kg P₂O₅ ha⁻¹ gave the highest seed yield, haulm yield as well as biological yield which were found

significantly higher over the other phosphorus levels except 40 kg ha⁻¹ during the years. This might be due to higher application of phosphorus, the process of tissue differentiation from stomatic to reproductive, meristematic activity and development of floral primordium might have been enhanced causing greater number of flowers which later developed in pods. Phosphorus requirement of pod and developing seeds is met by mobilization of pre-assimilated nitrogen from subtending leaves. It is well known fact that developing pod receives most of photosynthate from subtending leaves. In addition, under higher supply of nutrients, this might be more efficient translocation of photosynthates from leaves via stem to stalk site that is the pod and the seeds. This resulted in higher number of seeds, which on maturity became bold with higher test weight and finally increased the yield. Similar results with phosphorus were also recorded by Yadav *et al.*, (2014), Meena *et al.*, (2015), Bhathal and Kumar (2016), Verma *et al.*, (2017b), Singh *et al.*, (2017) and Kumawat *et al.*, (2018).

Effect on economics

The net returns and B:C ratio significantly influenced by weed control treatments and phosphorus levels during both the years (Table 2). Among the various weed control treatments, mixture application of Pendimethalin + Imazethapyr (RM) @ 0.8 kg ha⁻¹ with one HW gave significantly highest net return and B:C ratio however, it was found at par with Imazethapyr + Imazamox @ 0.05 kg ha⁻¹ with 1 HW at 30 DAS and 2 HW at 15 DAS and 30 DAS. The low investment coupled with good economic yield might be the reason for higher net returns and B:C ratio of these treatments combinations. Similar findings were also reported by Lhungdim *et al.*, (2013), Chandrakar *et al.*, (2014) and Punia *et al.*, (2017).

The further data revealed that application of 60 kg P₂O₅ ha⁻¹ gave highest net returns while, B:C ratio was recorded in 40 kg P ha⁻¹ during both the years (Table 4.2). These results are agreement with Singh *et al.*, (2014), Singh *et al.*, (2017), Kumawat *et al.*, (2018) and Kumawat *et al.*, (2020).

It is concluded that application of Pendimethalin 1.0 kg + Imazethapyr 0.8 kg ha⁻¹ with one hand weeding at 30 DAS and 40 kg P₂O₅ ha⁻¹ may be recommend for obtaining higher productivity and profitability of clusterbean under sub-tropical climatic conditions of Rajasthan.

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How to cite this article:

Surendra Kumar Meena, S. L. Mundra, Raghuvir Singh Meena, H. K. Sumariya, Piyush Chaudhary, Tikendra Kumar Yadav and Narendra Kumawat. 2020. Response of Clusterbean (*Cyamopsis tetragonoloba* L.) to Weed Management Practices and Phosphorus Levels under Sub-tropical Climatic Conditions of Rajasthan. *Int.J.Curr.Microbiol.App.Sci* 9(09): 748-755. doi: <https://doi.org/10.20546/ijcmas.2020.909.094>